Integrated Water Quality and Aquatic Communities Protocol – Wadeable Streams

Standard Operating Procedure (SOP) #10: Discharge Measurement

Draft Version 1.0

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedure for measuring the discharge of wadeable streams. Stream discharge, the volume of water passing a point over a standard unit of time (usually seconds), is equal to the product of the mean current velocity and vertical cross sectional area of flowing water. Discharge is critical for assessing chemical and biological trends in stream communities. This can be due to either dilution of solutes or its effects on sampling efficiency. For example, specific conductivity is typically lower at higher discharge levels, and the collection efficiency of macroinvertebrates decreases at above 400 cubic feet per second in smaller streams. Discharge is typically measured close to the X-Point, where chemistry is measured. However, if no suitable location for discharge is near the X-Point, it can be conducted anywhere along the sample reach. Discharge should always be determined after collecting water chemistry samples, and no sampling activity should be occurring immediately upstream (within 10 m) during the discharge measurements. We use the mid-section equation of the USGS for calculation of discharge.

Discharge Measurement

The preferred procedure for obtaining discharge data is based on “velocity-area” methods (e.g., Rantz et al. 1982, Linsley et al. 1982). Since velocity and depth typically vary greatly across a stream, accuracy in field measurements is achieved by measuring the mean velocity and flow cross-sectional area of many equal increments of width across a channel, typically between 10 and 20 increments. Each increment gives a subtotal of the stream discharge and the whole is calculated as the sum of these parts. Discharge measurements are made at only one carefully chosen channel cross-section within the sampling reach. It is important to choose a channel cross-section that is as much like a canal as possible. A glide area with a "U" shaped channel cross-section, laminar flow, and free of obstructions provides the best conditions for measuring discharge by the velocity-area method (Figure 1). You may remove rocks and other obstructions to improve the cross-section before measurements are made. It is also helpful to excavate the borders of the channel cross-section to ensure that there is adequate depth at the midsection of the first and last increments for an accurate velocity measure to be obtained. This “engineering” in no way alters the amount of discharge, however, because removing obstacles or altering the

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substrate of the channel cross-section affects adjacent water velocities, you must not change the cross-section once you commence collecting the set of velocity and depth measurements. Also note that if the suitable cross-section occurs at a transect, discharge and “engineering” should only occur after macroinvertebrate and periphyton sampling.

1. Locate a cross-section of the stream channel for discharge determination that has most of the following qualities (based on Rantz et al. 1982):
    a. Segment of stream above and below cross-section is relatively straight.
    b. Depths mostly greater than 0.5 ft, and velocities mostly greater than 0.15 meters/second. **Do not measure discharge in a pool**.
    c. "U" shaped, with a uniform streambed free of large boulders, woody debris, brush, and dense aquatic vegetation.
    d. Flow is relatively uniform and laminar, with no eddies, backwaters, or excessive turbulence.

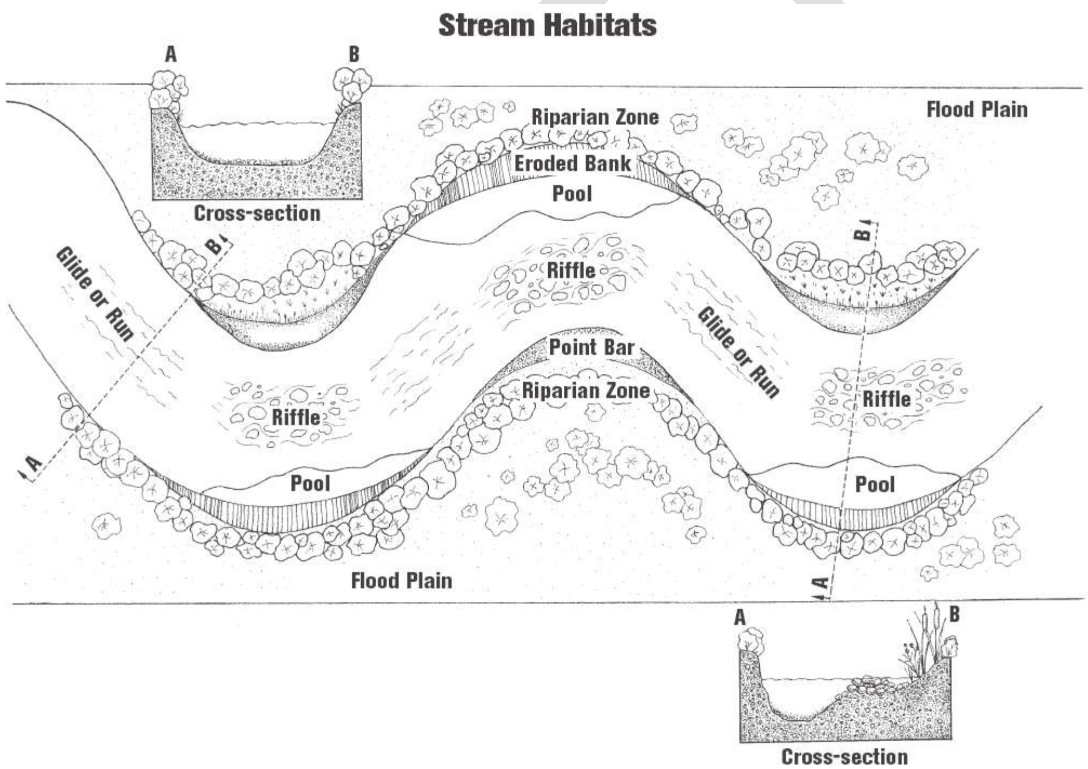

Figure 1. Potential discharge measurement channel cross section placements within a stream. The cross-section on the left has the ideal qualities for the measurement of discharge. The cross-section on the right has an irregular depth profile, substrates that cause turbulent flow, and aquatic vegetation near the bank, therefore making it an unacceptable channel cross-section for the measurement of discharge (from TCEQ 2008).

2. Stretch the metric tape across the stream perpendicular to its flow, with the “zero” end of the tape on the left bank, as viewed when looking downstream. Leave the tape tightly suspended across the stream, approximately one foot above water level. Use piles of rocks, surrounding vegetation, or tent stakes to suspend the tape above the stream. Do not

allow the metric tape to contact the stream water as this may affect velocity measurements.

3. Attach the velocity meter probe to the calibrated wading rod. Check to ensure the meter is functioning properly and the correct calibration value is displayed. Calibrate (or check the calibration) the velocity meter and probe as directed in the flowmeter's operating manual (Appendix Q); The FlowTracker ADV has an auto QC function for this purpose. An alternative, quick calibration check that can be performed in the field is to place the probe at 60% of the depth of completely motionless water in a 5 gallon bucket and to check for 0 velocity.

4. Divide the total wetted stream width into 10 or 20 equal-sized increments. Use 10 increments if the channel cross-section is less than or equal to 3 m wide and use 20 increments if the channel cross-section is greater than 3 m wide. Avoid measuring discharge at channel cross-sections greater than 10 m wide. The first increment is located at the left margin of the stream (0 cm, depth may also be 0 cm) (left when looking downstream), and the last increment is located at the right margin of the stream (right when looking downstream) (Figure 2).

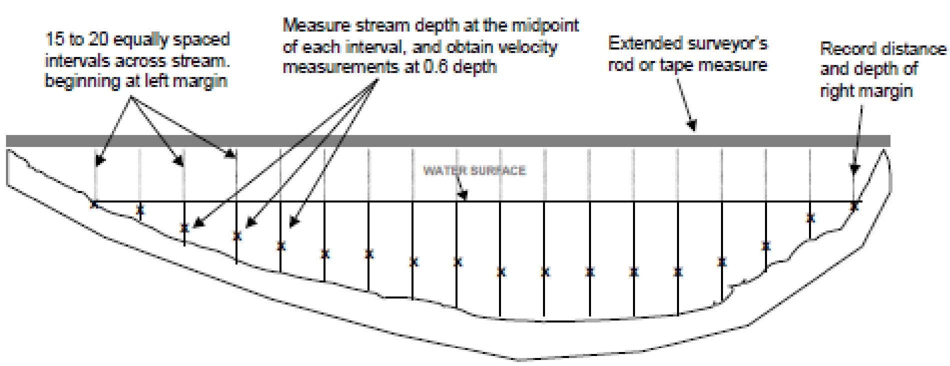

Figure 2. Diagram of placement of cross-sectional measurement for velocity.

5. Stand downstream of the tape and to the side of the first interval point (closest to the left bank if looking downstream). Keep feet shoulder width apart, hold the wading rod vertically with the hand of a fully extended arm, and keep submerged parts of your body motionless so as not to agitate the water possibly effecting the velocity measurement.

6. Place the wading rod in the stream at the midpoint of the first increment and check the attached bubble level to ensure that the wading rod is near vertical. Face the probe upstream at a right angle to the cross-section, even if local flow eddies hit at oblique angles to the cross-section.

7. If the depth of the increment is less than or equal to 2.0 ft, adjust the probe position of the probe on the wading rod so it is at 60% of the measured depth below the surface of the water. The wading rod is designed so that this can quickly be accomplished (Figure 3).

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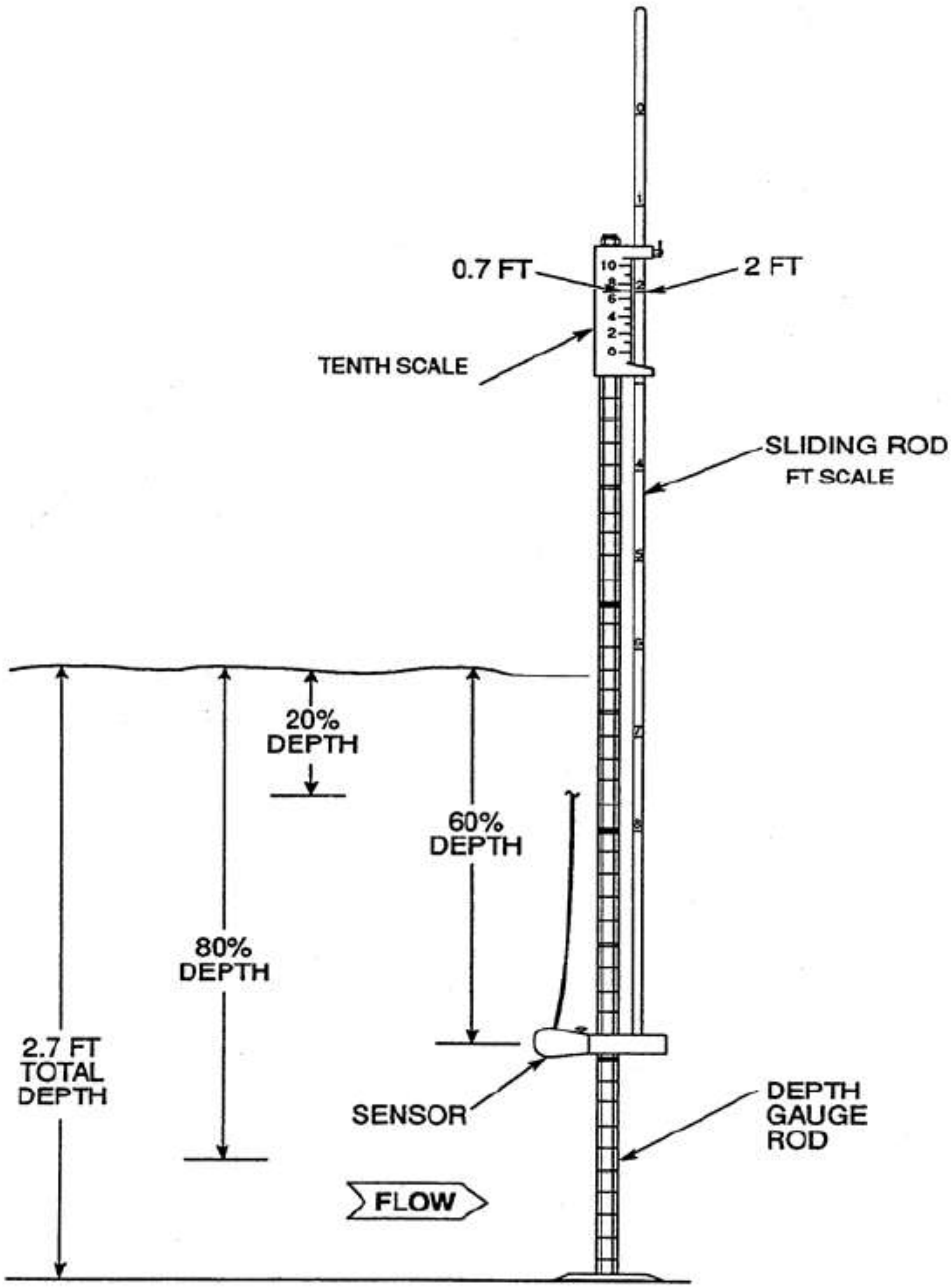

Figure 3. Diagram of the wading rod. In this example, the depth is 2.7 ft, and when the sliding rod is set at 2.7; the sensor is automatically at 60% of the water depth.

   a. Each single line on the wading rod is 0.1 ft, each double line 0.5 ft, and each triple line 1.0 ft of depth. Using these marks, determine the total depth of the increment and **record on the data form, in tenths of ft**.
   b. The wading rod has two side by side components that slide vertically beside each other so that the correct depth of the probe can be set. On the sliding portion are whole numbers representing feet of depth. On the stationary portion there is a tenths scale near the handle representing tenths of feet of depth (Figure 3). Slide the sliding portion upward until the whole number of the feet of measured depth aligns with the tenths-of-feet number of the measured depth (for example, if the measured depth of the increment is 1.2 ft, slide the rod upward until the “1” on the sliding portion aligns with the “0.2” on the tenths scale on the stationary portion). With the rod set in this manner, the probe is 60% of the measured depth.

8. Turn on the Sontek FlowTracker hand held unit by depressing the yellow power button and holding for 1 second.
   a. The FlowTracker is capable of auto calculating discharge in the field using a variety of equations. For ease of use, we use the FlowTracker in “General” mode to simply obtain an averaged velocity over 10 seconds. To select “General” mode and 40 seconds, enter “1” from the main menu. Follow the menu prompt to ensure the setting are: (1) Metric; (2) Avg Time (10); and (3) Mode General.
   b. Exit back to Main Menu by pressing “0.”

9. To measure the velocity, press “3: Start Data Run.” Create a Data File Name (this can be anything – we will not use the data file, it is merely a process required). Once a name is created, push “9: Accept name.”

10. Push “9: Start” to begin data collection. If this is the first point, select “1: Run Test” when prompted under the Automatic QC Test.

11. After QC test is performed, push “Measure,” the upper right button. Hold the probe steady during the 40 second countdown. **Record the Vx as the measured velocity at that point.**

12. Move to the next interval point, set the correct staff height, record the total depth, and depress “2: Repeat” to take the next velocity reading. Continue until depth and velocity measurements have been recorded for all intervals.

13. At the last interval (nearest to the right margin), record a “Z” flag on the field form to denote the last interval sampled.

14. Turn the FlowTracker off by depressing and holding the power button (about 10 seconds).

General Notes and Care about the FlowTracker

The Flowtracker is an expensive item and care should be given to prevent damage to it. While it is untenable to transport the FlowTracker to and from remote sites in the provided storage case, a bag to prevent sand and outside equipment from marring the equipment should be utilized. Also, the crew must carry spare AA batteries (8), a Philips head screwdriver to access the battery compartment, and spare thumb screws for securing the sensor to the wading staff.

Literature Cited

Linsley, R. K., M. A. Kohler, and J. L. H. Paulhus. 1982. Hydrology for engineers. McGraw-Hill, New York.

Rantz, S. E., and coauthors. 1982. Measurement and computation of streamflow: Volume 1. Measurement of stage and discharge. U.S. Geological Survey, Water Supply Paper 2175, Washington, D.C.

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